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MODERN LIGHTING

Examples of its Successful Application in the Industries

1920

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1920

ENGINEERING DEPARTMENT
NATIONAL LAMP WORKS
of GENERAL ELECTRIC CO.

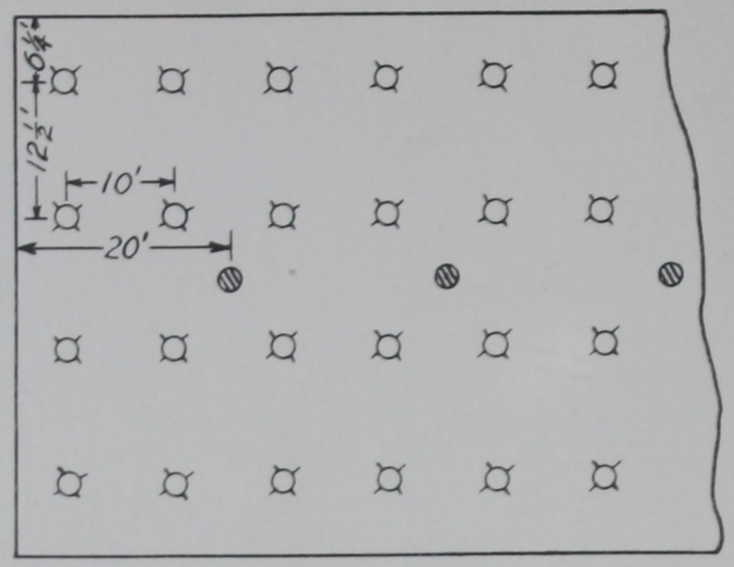
Foreword

THE eye requires a certain amount of time and the expenditure of a certain amount of effort to see an object clearly. Under good lighting, the time required is less and the effort required smaller than under poor lighting. The result is that under good light, production speeds up, and the increased output is obtained without strain or added exertion on the part of the workman. One has only to compare the good lighting installations reproduced in this book with the bad to realize that eliminating delays—and so increasing production—through improved lighting is something more than a theory.

In examining these reproductions, one should imagine himself the workman on the job. The clearness with which details are revealed, the softness of the light, the absence of serious direct and reflected glare, and the cheerful, stimulating appearance of the room will then take on a new and more emphatic meaning. Not only are the attributes of improved lighting just mentioned responsible for substantial increases in production but for marked decreases in spoilage and for greatly reduced accident hazard as well. Of several hundred manufacturers who were asked what in their opinion were the chief benefits of good lighting, 79% named increase in production; 71%, decrease in spoilage; 60%, prevention of accidents; 51%, improvement in discipline; 41%, improvement of hygienic conditions.

Although the aim has been to have these illustrations show as nearly as possible the true lighting effects, no retouching of any kind has been resorted to. The printed pages are faithful reproductions of what the camera saw. In this connection it should be stated that the illumination values given in the data accompanying the pictures have been discounted to allow for reasonable accumulation of dust and dirt between cleaning periods. They represent, therefore, the average working illumination.

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This armature-winding room is an instance where within a period of a year the plant management found it profitable to increase the illumination by three successive steps from 5 foot-candles to 17 foot-candles. It was felt that the cost of light was negligible compared with the total cost of production.

Just how far it pays to go in increasing the quantity of light supplied for different manufacturing operations has not yet been determined. In shops considered well supplied with daylight, the illumination usually ranges from 10 to 25 foot-candles.

Data—Plate One

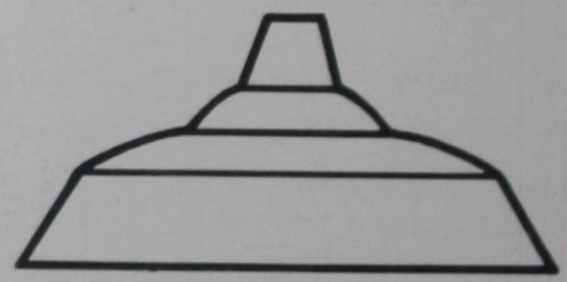
Type of Unit
RLM Standard Dome

Lamp
300-watt Mazda C
Bowl-Enameled

Mounting Height
11 feet above floor
8 feet above work

Spacing Distance
10 x 12½

Average Illumination
17 foot-candles



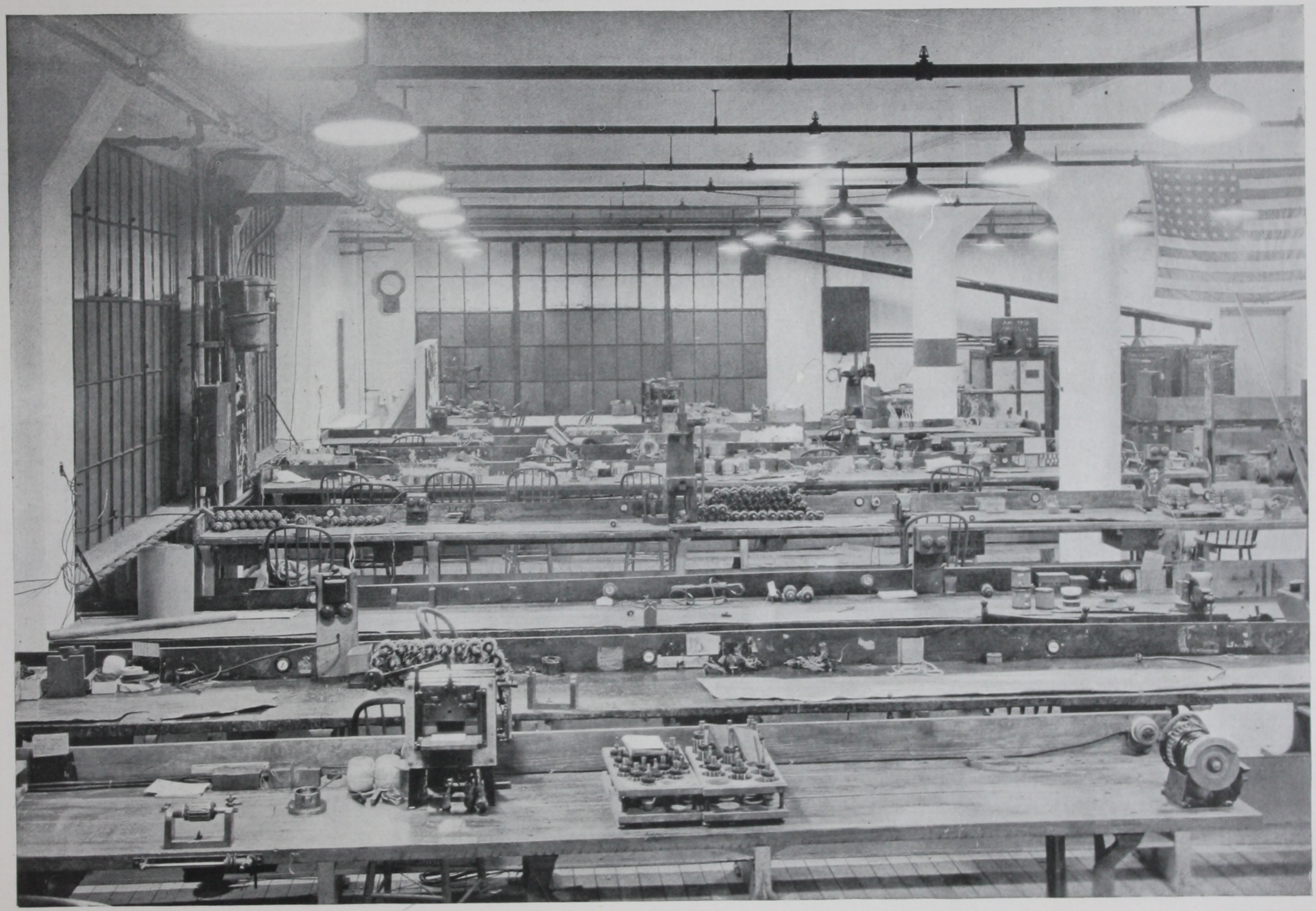
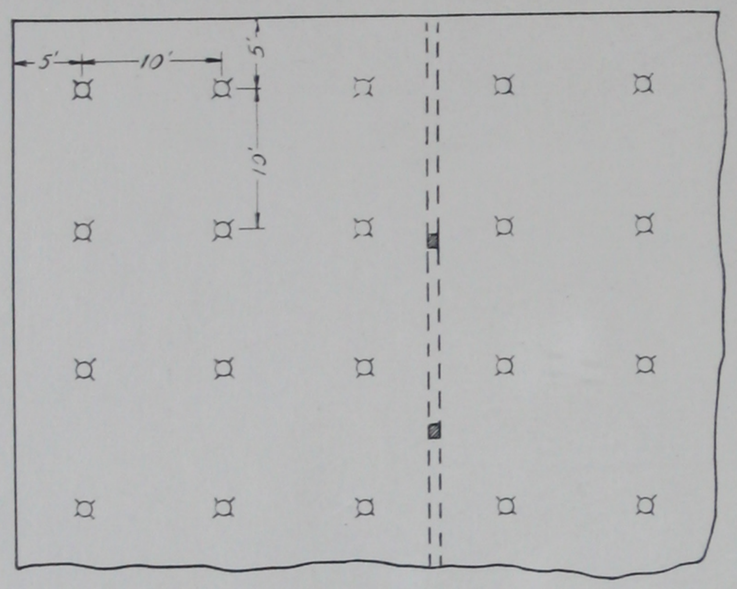


PLATE ONE



In this assembly room, the diffusion of light from sources of large area enables the workmen to see readily into the interior of the castings. This facilitates the assembly of sewing machine heads by eliminating small losses of time, and so becomes an important factor in increasing production. Note the softness of the shadows cast upon the floor by the benches. No time need be lost in groping for parts or tools where such a system of illumination is in use.

Data—Plate Two

Type of Unit
RLM Standard Dome

Lamp
150-watt Mazda C
Bowl-Enameled

Mounting Height
11 feet above floor
7½ feet above work

Spacing Distance
10 x 10

Average Illumination
9 foot-candles

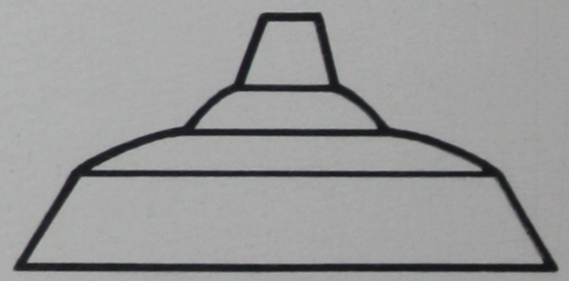
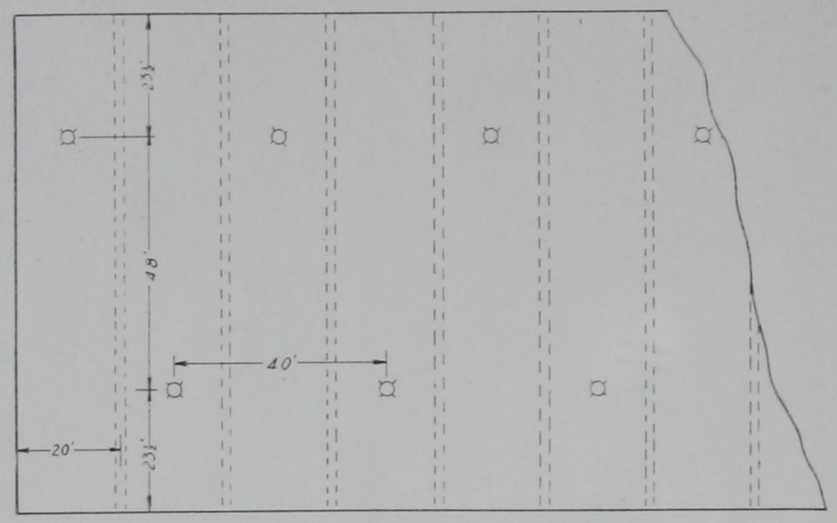




PLATE TWO



Where the mounting height is 30 feet or more, the larger sizes of clear MAZDA C lamps will be found economical, and unobjectionable from the standpoint of direct glare.

In an interior of this type, the units must be mounted at a sufficient height above the work to clear the crane,—with the result that large MAZDA C lamps may be used at relatively wide spacing distances.

DATA—PLATE THREE

TYPE OF UNIT
Porcelain-Enameled
Steel Dome

LAMP
1000-watt MAZDA C
Clear

MOUNTING HEIGHT
40 feet above work

SPACING DISTANCE
48 x 40

AVERAGE ILLUMINATION
4 foot-candles

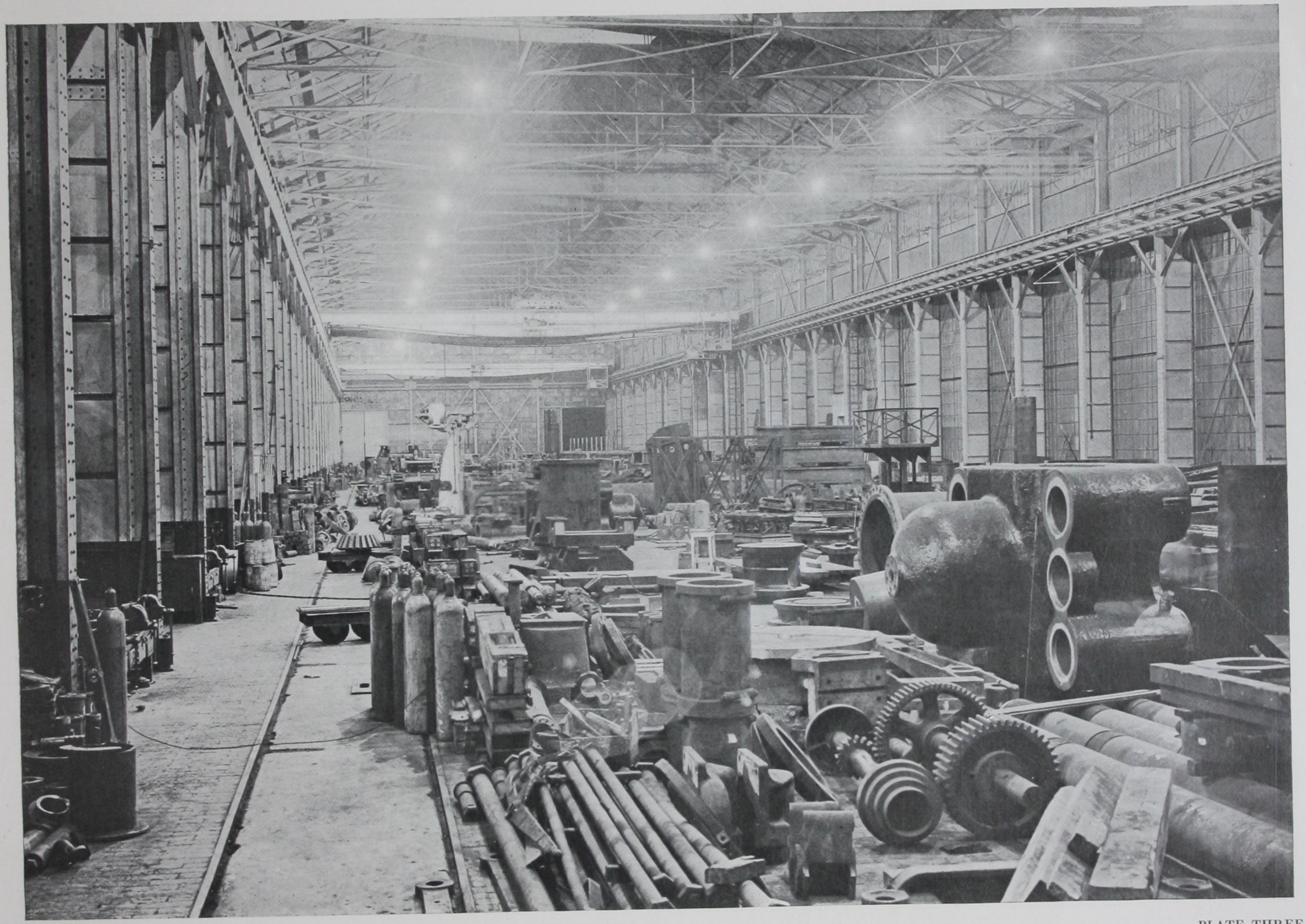
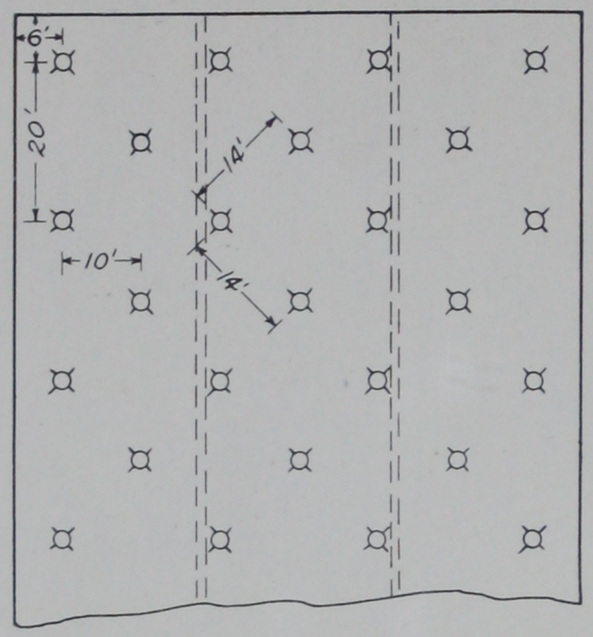


PLATE THREE



Where there are many overhead belts, it is often advantageous to permit a small proportion of the light to reach the upper part of the room direct. Where this unit is used, a gloomy appearance of the ceiling—a condition which may be observed in the shop pictured in Plate Eight—is avoided.

The management of this plant has found the illumination insufficient. In buildings which they now have under construction, provision has been made for practically double this illumination from units of the same type.

Data—Plate Four

Type of Unit
Glass-Top Steel Dome

Lamp
200-watt Mazda C
Bowl-Enameled

Mounting Height
12 feet above floor
9 feet above work

Spacing
14 x 14 (Staggered)

Average Illumination
6 foot-candles

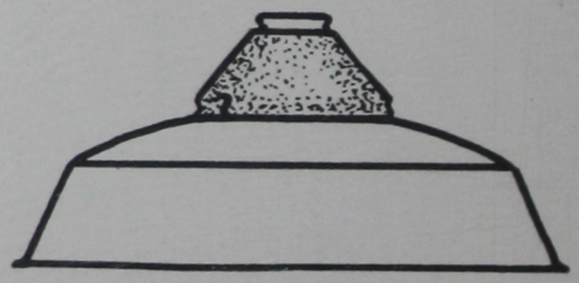
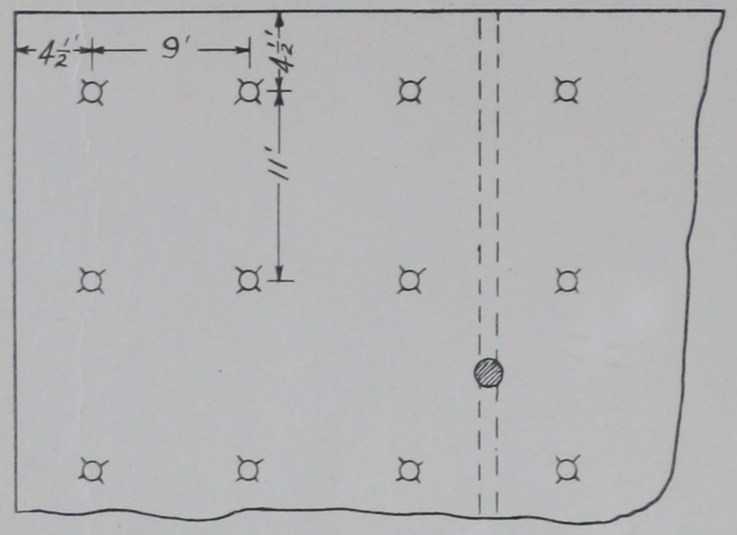




PLATE FOUR



A relatively large quantity of light is desirable for the precise work of assembling small parts for adding machines. In this installation, light surfaces on the work benches reflect sufficient light to the ceiling to create a bright and cheerful appearance.

The sharp shadows cast upon the floor by the chairs suggest the possibility for improvement through the use of bowl-enameled lamps.

Data—Plate Five

Type of Unit
RLM Standard Dome

Lamp
200-watt Mazda C
Clear

Mounting Height
9½ feet above floor

Spacing Distance
9 x 11

Average Illumination
14 foot-candles

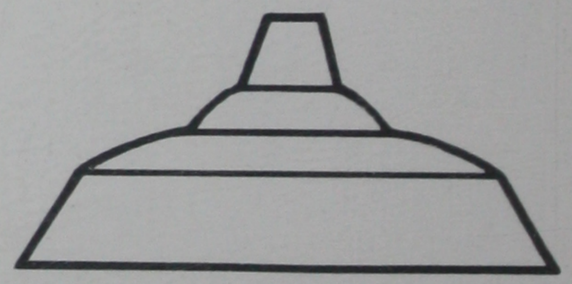
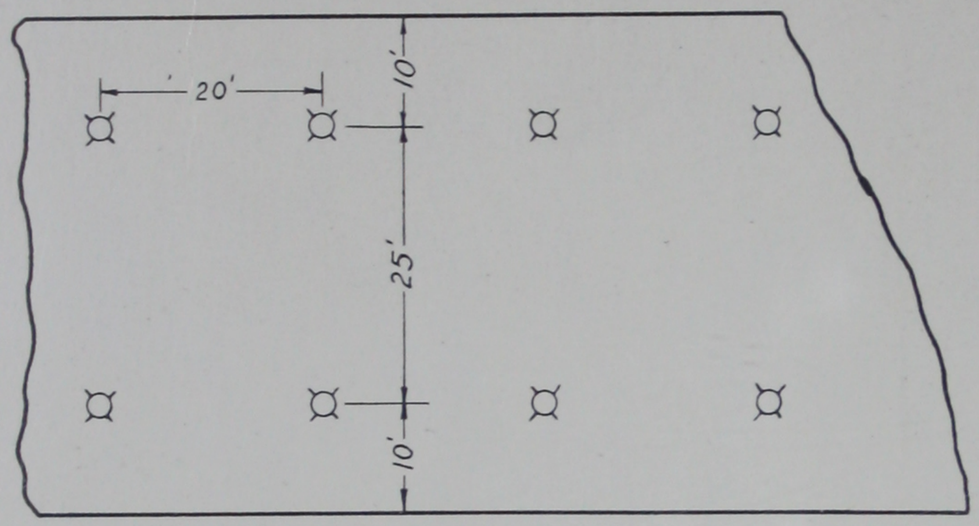




PLATE FIVE



Contrary to popular opinion, the use of RLM Standard dome reflectors in this shop would have resulted in an increase in illumination and the installation would have been as satisfactory in all other respects. In many plants, more light would have been found desirable for this class of work.

In a building of this character, angle units mounted under the crane-way would be of considerable value as a supplement to the overhead system. In some parts of this room, it has been found desirable to install auxiliary units under the balconies.

Data—Plate Six

Type of Unit
Porcelain-Enameled
Steel, Deep Bowl

Lamp
500-watt Mazda C
Clear

Mounting Height
40 feet above floor
35 feet above work

Spacing Distance
20 x 25

Average Illumination
5 foot-candles

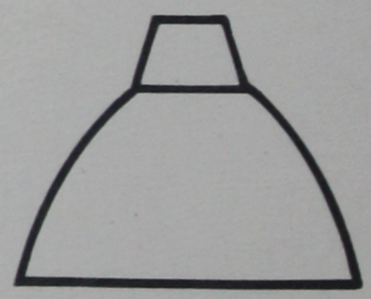




PLATE SIX



PLATE SEVEN

Data—Plate Seven

The Old

Type of Unit
Some cone shades

Lamp
Carbon, Gem, Mazda B

Mounting Height
Irregular, drop cords

Spacing Distance
Irregular

Average Illumination
0.2 foot-candles.

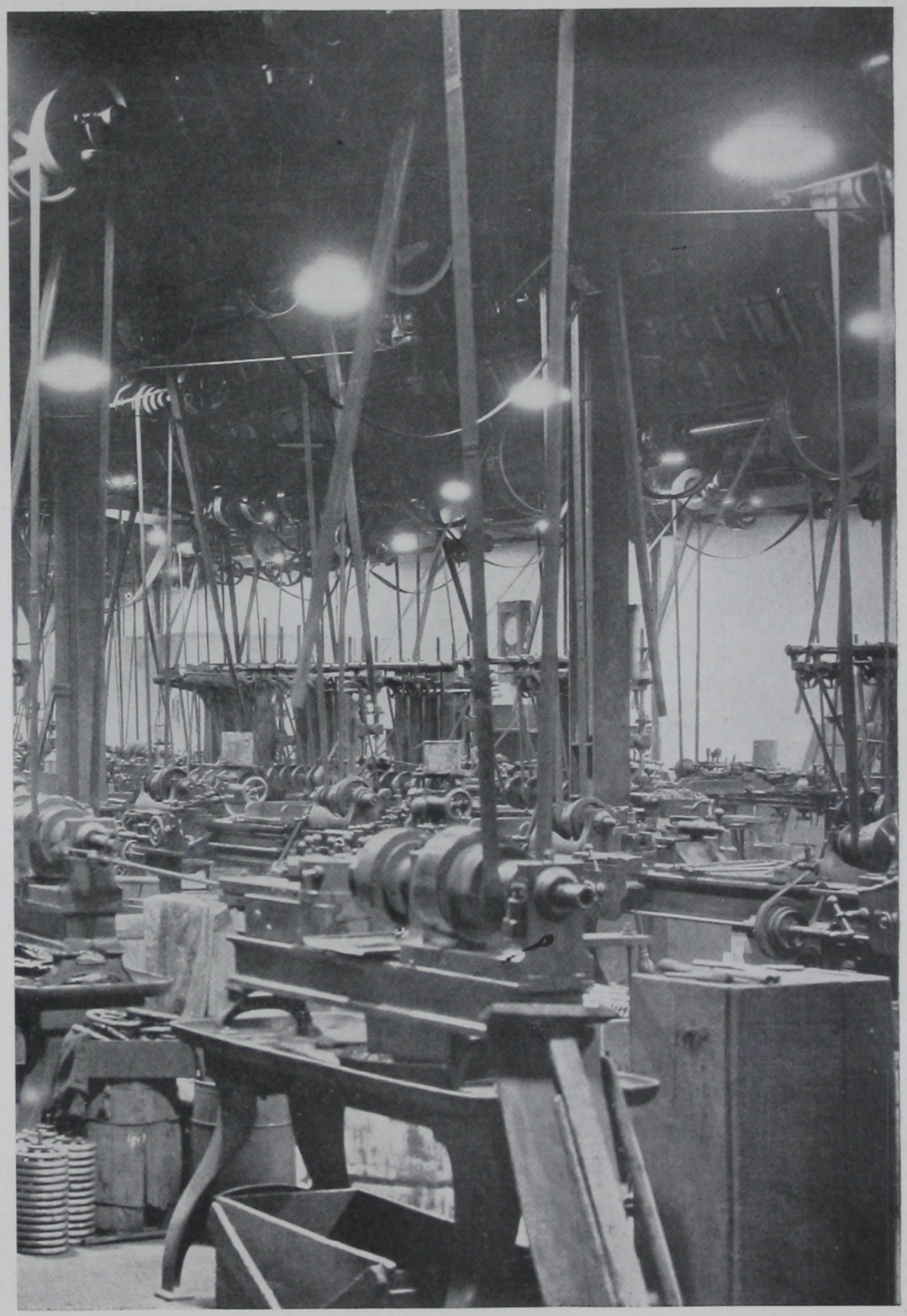


PLATE EIGHT



Data—Plate Eight

The New

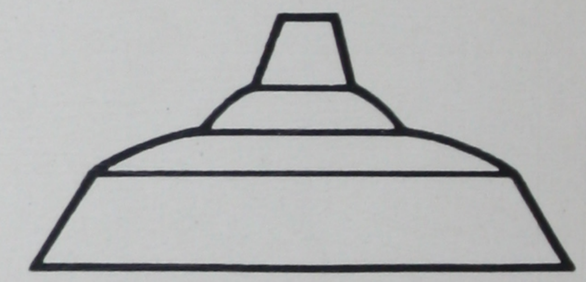
Type of Unit
RLM Standard Dome

Lamp
100-watt Mazda C
Bowl-Enameled

Mounting Height
11 feet above floor
7½ feet above work

Spacing Distance
10 x 10

Average Illumination
6 foot-candles



This is the interior shown in Plate Seven as it appears under the new system of general lighting. It is easy to understand how a change in the lighting of the kind here shown is accompanied by a decrease in the accident hazard and by an improvement in morale, discipline, and cleanliness. Under the new system, it has been possible for the first time to use a regular night shift on this work.

Were the area overhead painted white, this room would more closely resemble the assembly room shown in Plate Two.



PLATE EIGHT



The glaring local light shown above is a menace to safety and vision and is one of the evils which Lighting Codes are aiming to destroy. Contrast the lighting of this milling machine and the lighting of those shown in Plate Nine.

In using a unit such as the metal-cap diffuser, it is essential that the spacing distance be not more than 1½ times the mounting height of the unit above the plane of work.

DATA—PLATE NINE

TYPE OF UNIT
Metal-Cap Diffuser

LAMP
200-watt MAZDA C
Clear

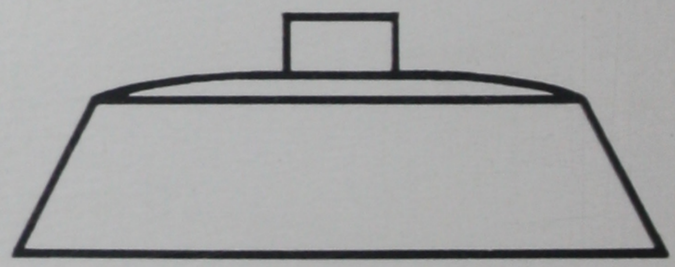
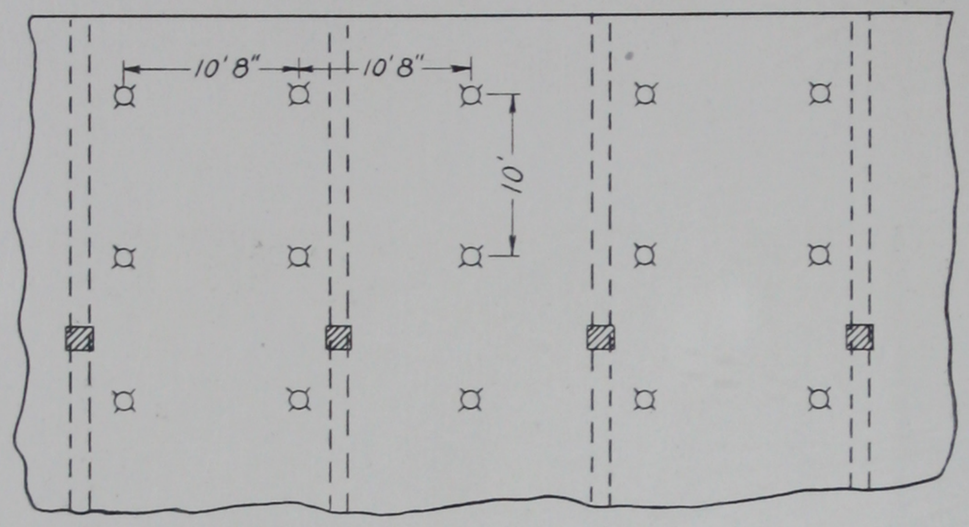




PLATE NINE



Where the work is being done on glossy surfaces or polished metals, it is essential that the light be well diffused in order to avoid annoying reflections. This has been accomplished in this instance by the use of the metal-cap diffuser.

Such a system makes the installation of local lamps unnecessary.

Data—Plate Ten

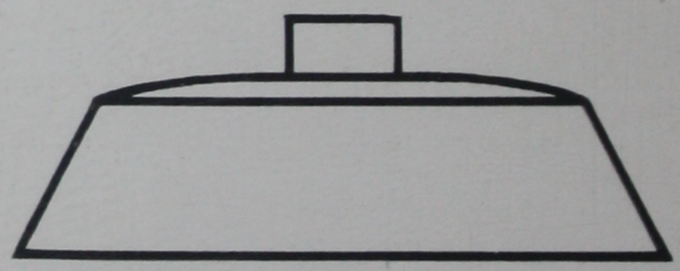
Type of Unit
Metal-Cap Diffuser

Lamp
200-watt Mazda C
Clear

Mounting Height
10½ feet above floor

Spacing Distance
10 ft. x 10 ft. 8 in.

Average Illumination
9 foot-candles



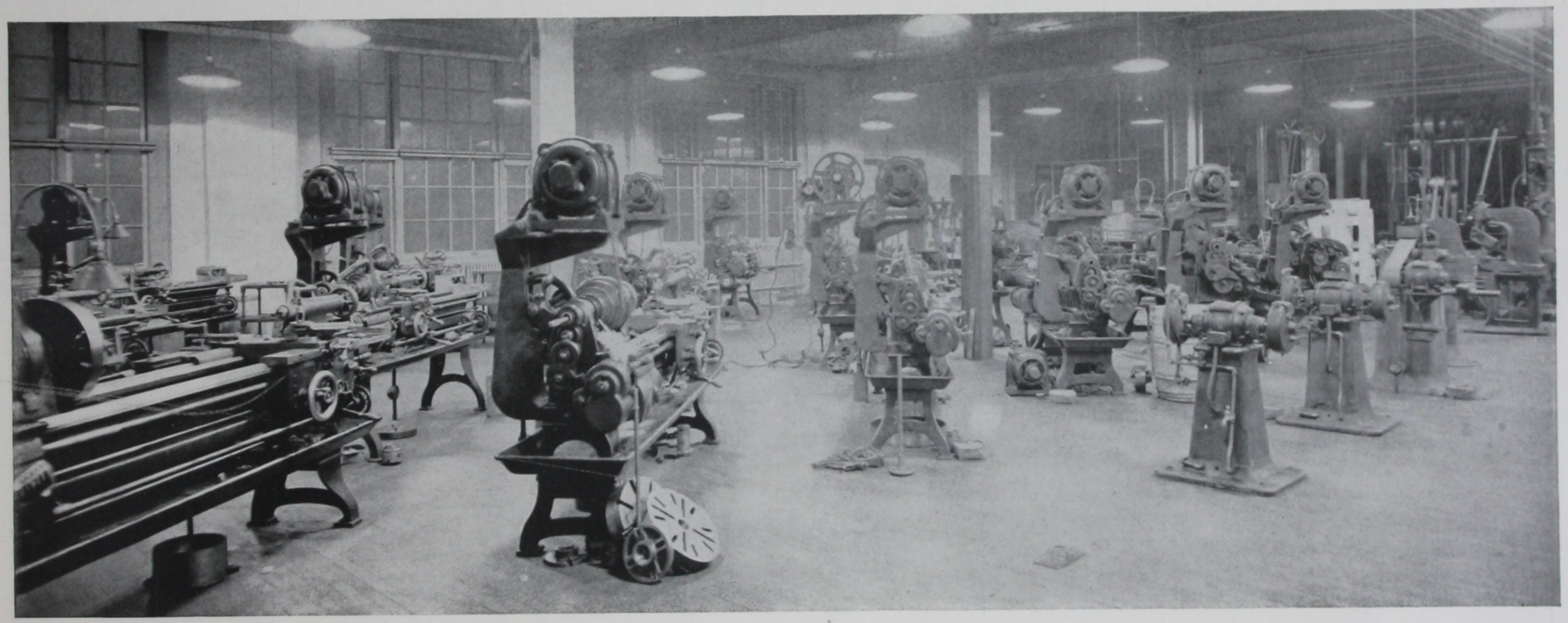
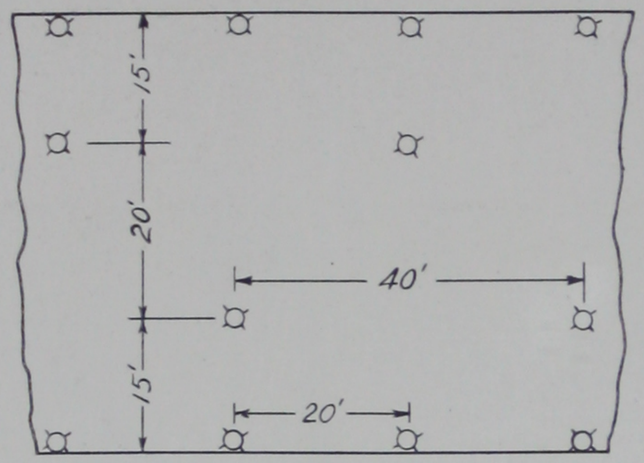


PLATE TEN



The use of angle units mounted beneath the crane-way to supplement a general overhead system will materially assist in the illumination of lateral surfaces by giving light from the direction of normal daylight. The angle units should be carefully designed and properly installed to avoid direct glare.

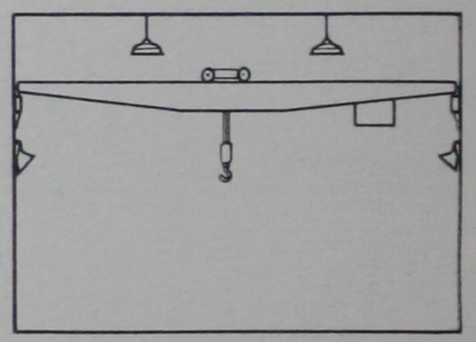
The light shining through the windows is from a system of yard lighting,—which is often desirable from a protective standpoint.

Data—Plate Eleven

Type of Unit

Porcelain-Enameled
Steel, Dome
Porcelain-Enameled
Steel, Angle





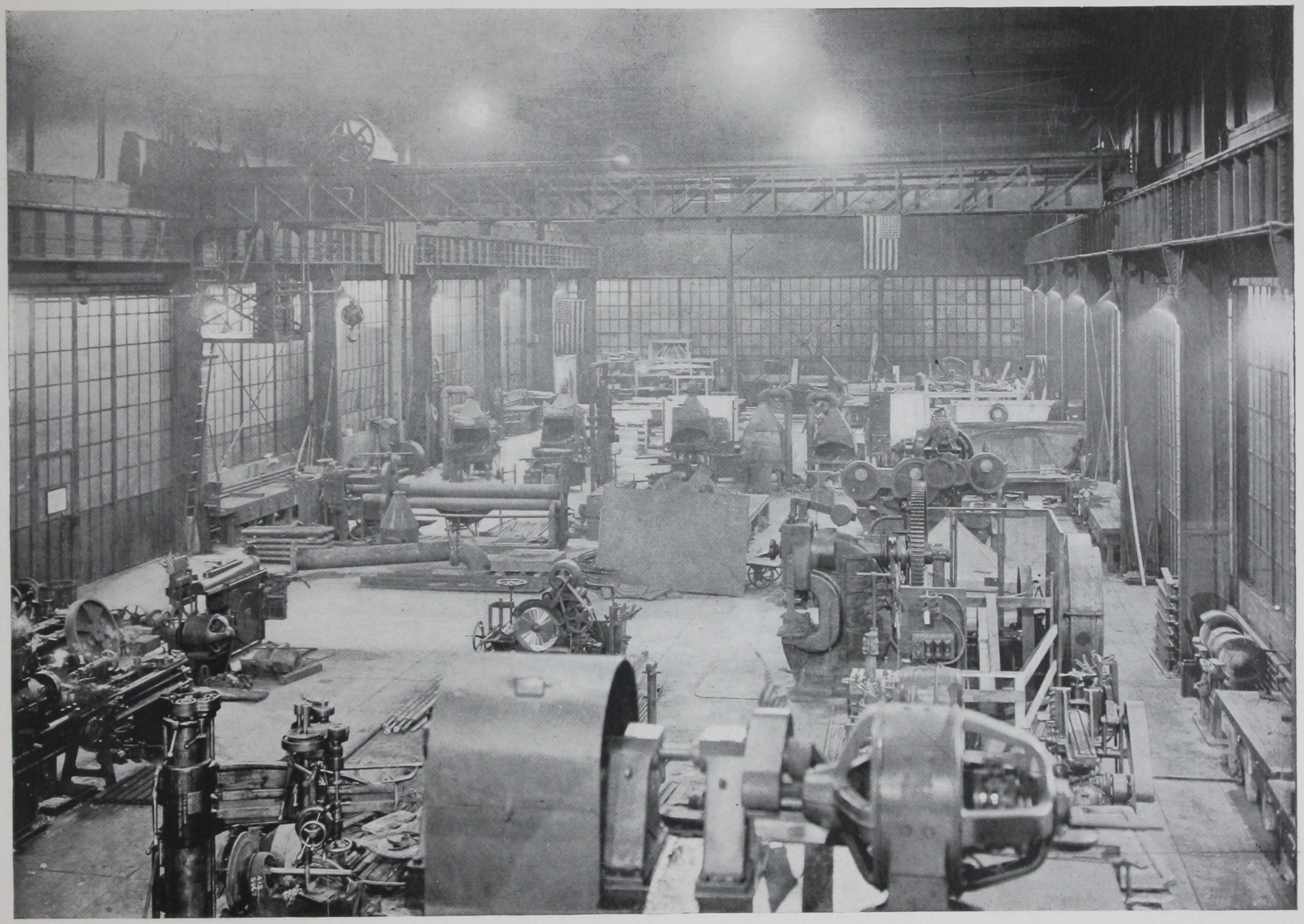
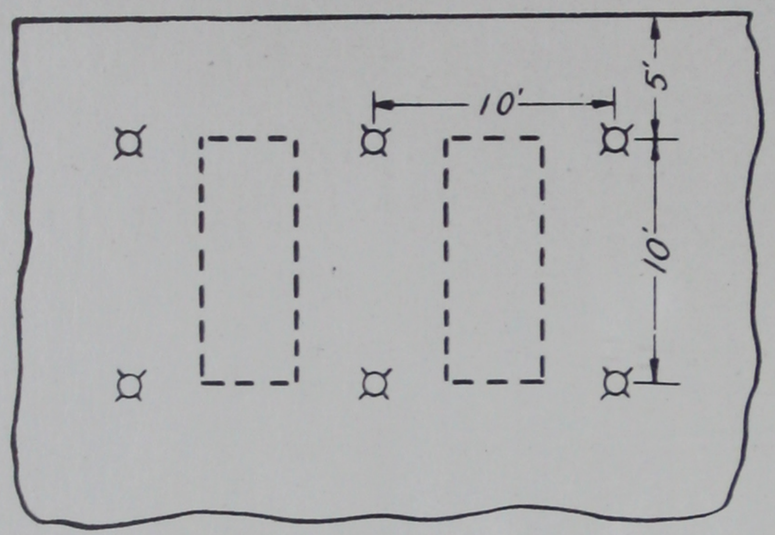


PLATE ELEVEN



The management of this plant lays great stress on the avoidance of spoilage in the operation of these veiling looms. Therefore a high value of illumination has been provided, its cost being considered unimportant in view of the reduced spoilage and greater output which result.

Local lighting for the most intricate machinery has been found unnecessary in this plant.

Data—Plate Twelve

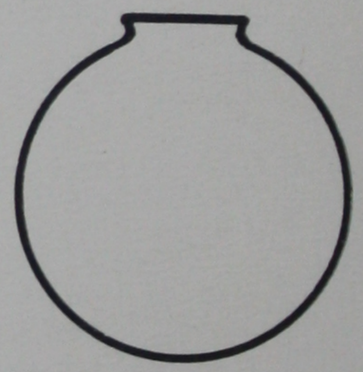
Type of Unit
Dense Opal Enclosing Ball

Lamp
500-watt Mazda C Clear

Mounting Height
13 feet above floor
6 feet above work

Spacing Distance
10 x 10

Average Illumination
20 foot-candles



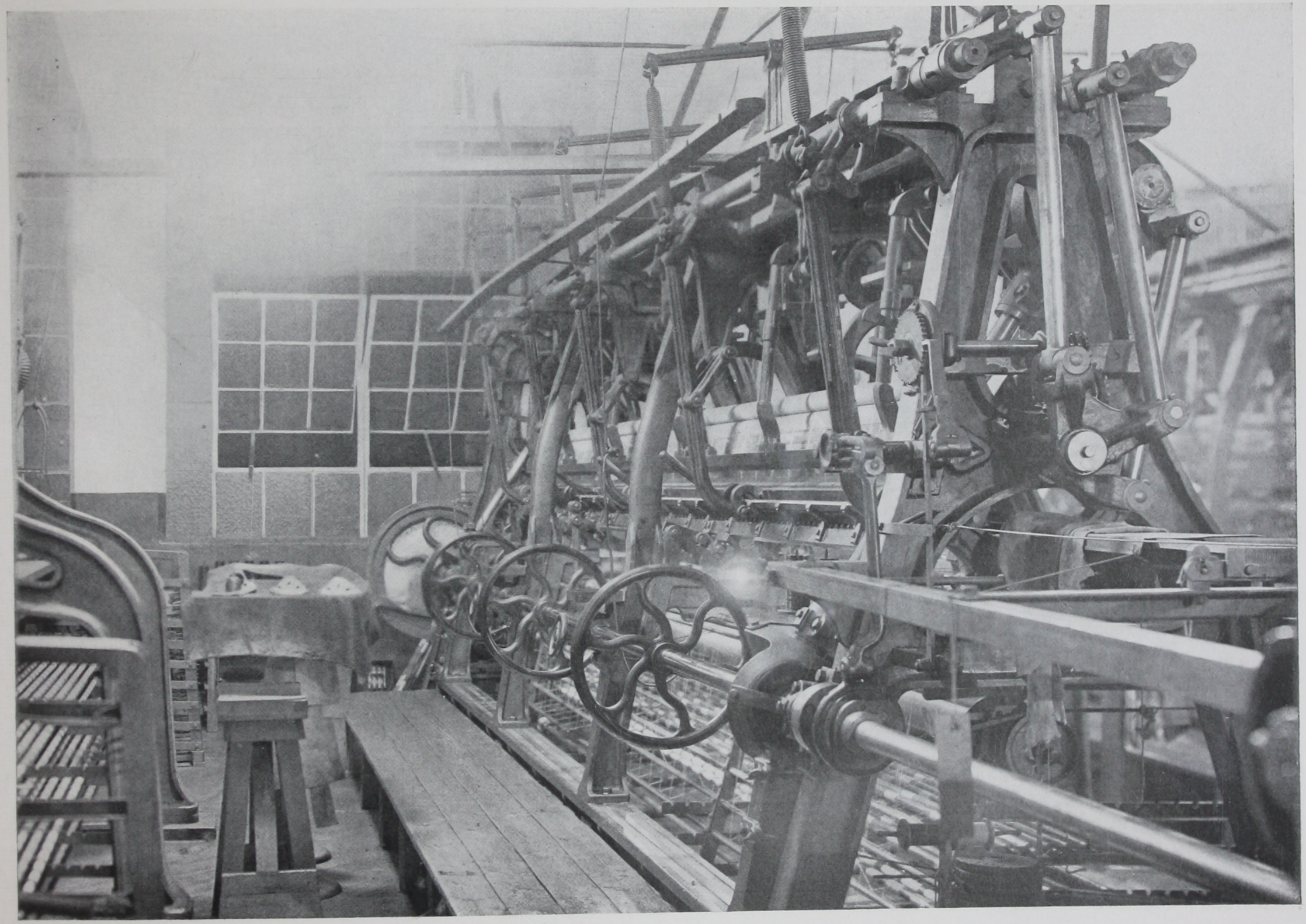
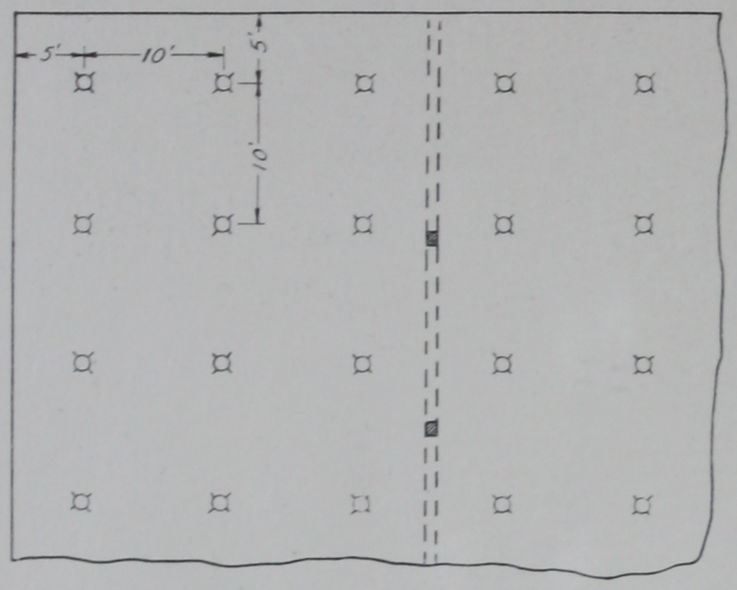


PLATE TWELVE



With the use of the bowl-enameled lamp and the RLM Standard dome reflector, direct glare and bad shadows may be avoided, and annoyance from reflected glare minimized. This equipment will be found the most satisfactory for a very large proportion of all industrial plants.

The advantage of using white paint on the walls is noticeable in this room; if the roof trusses were similarly whitened, the appearance of the room would be improved.

Data—Plate Thirteen

Type of Unit
RLM Standard Dome

Lamp
150-watt Mazda C
Bowl-Enameled

Mounting Height
11 feet above floor
7½ feet above work

Spacing Distance
10 x 10

Average Illumination
9 foot-candles

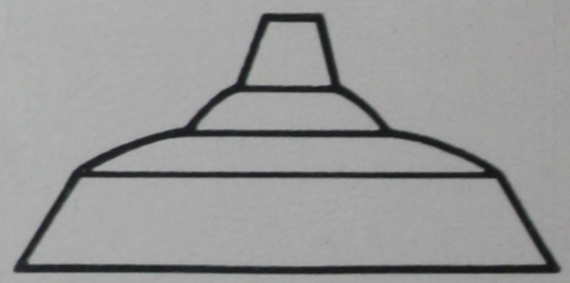




PLATE THIRTEEN



PLATE FOURTEEN

DATA—PLATE FOURTEEN

The Old

TYPE OF UNIT

Some cone shades

LAMPS

GEM, Carbon, MAZDA B

MOUNTING HEIGHT

Irregular, drop cords

SPACING DISTANCE

Irregular

As a strictly local lighting system, this might be described as good, yet the appearance of the room is dark and depressing. Reflections of the lamp filaments in the working surfaces are likewise a source of considerable annoyance to the workmen.

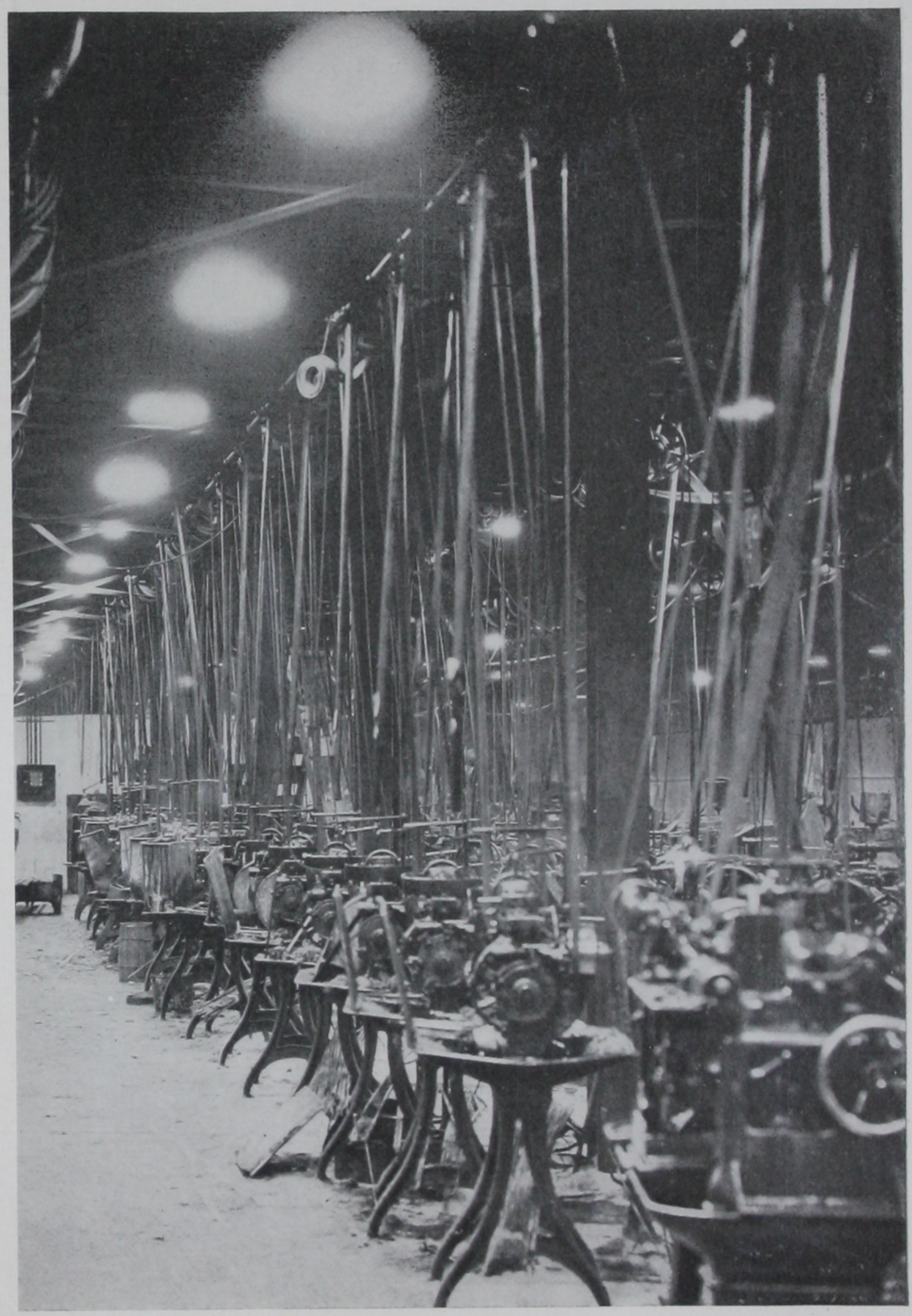


PLATE FIFTEEN



Data—Plate Fifteen

The New

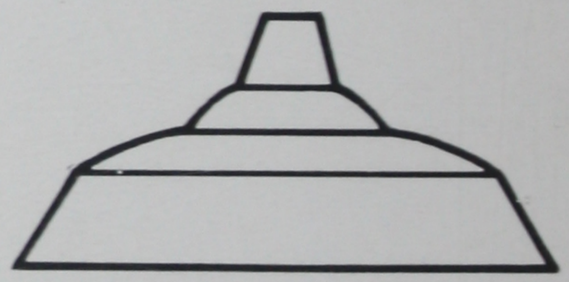
Type of Unit
RLM Standard Dome

Lamp
100-watt Mazda C
Bowl-Enameled

Mounting Height
11 feet above floor
7½ feet above work

Spacing Distance
10 x 10

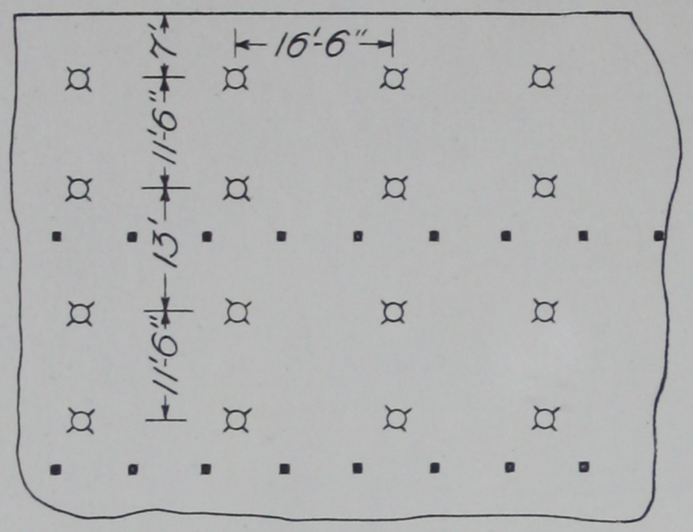
Average Illumination
6 foot-candles



The proverbial forest of belting as found in this screw-machine room, need not prevent an adequate supply of properly diffused light reaching the work from a general overhead system. Sources of large area are necessary to avoid sharp, black shadows.



PLATE FIFTEEN



The old lighting system in this weave room was considered a model at the time of its installation a few years ago. It consisted of 75-watt MAZDA C lamps and bowl-shaped steel reflectors on a spacing and mounting which was such as to insure uniform illumination. The defects of the system were, first, insufficient illumination—about 2½ foot-candles, and second, sharp, harsh shadows. Both of these defects were corrected simply by substituting 150-watt bowl-enameled MAZDA lamps and the proper size of RLM dome reflectors on the same outlets.

DATA—PLATE SIXTEEN

The New

TYPE OF UNIT
RLM Standard Dome

LAMPS
150-watt MAZDA C
Bowl-Enameled

MOUNTING HEIGHT
13½ feet above floor
10½ feet above work

SPACING DISTANCE
12¼ x 16½

AVERAGE ILLUMINATION
5 foot-candles

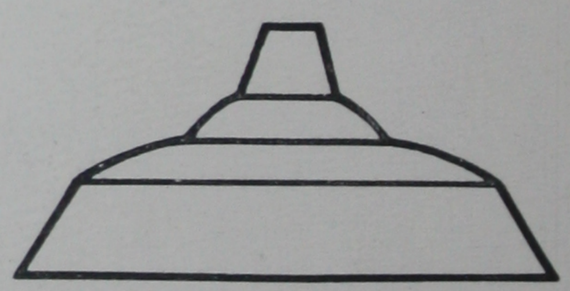
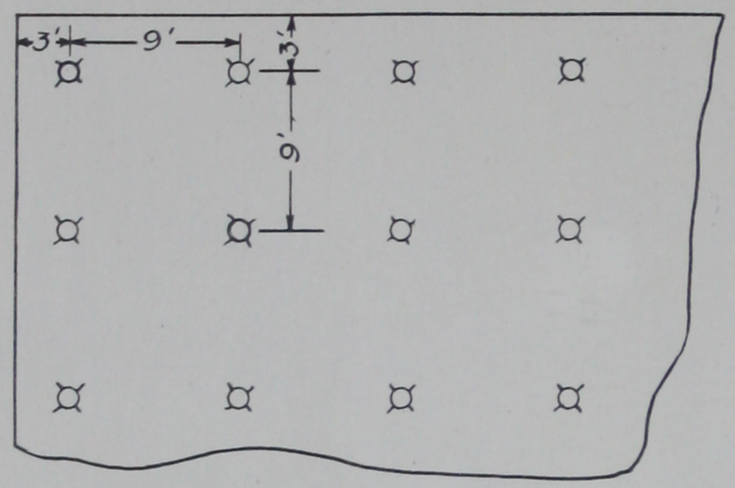




PLATE SIXTEEN



Good lighting in composing rooms is rare. There can be little doubt that the greater quantity of work turned out in this room much more than pays the difference in cost between poor and good lighting.

With units of the type used in this case, the greater part of the light is directed to the ceiling whence it is diffused throughout the room.

DATA—PLATE SEVENTEEN

TYPE OF UNIT
Duplexalite

LAMP
200-watt MAZDA C
Clear

MOUNTING HEIGHT
9 feet above floor

SPACING DISTANCE
9 x 9

AVERAGE ILLUMINATION
10 foot-candles

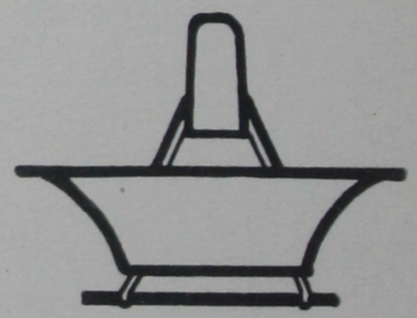
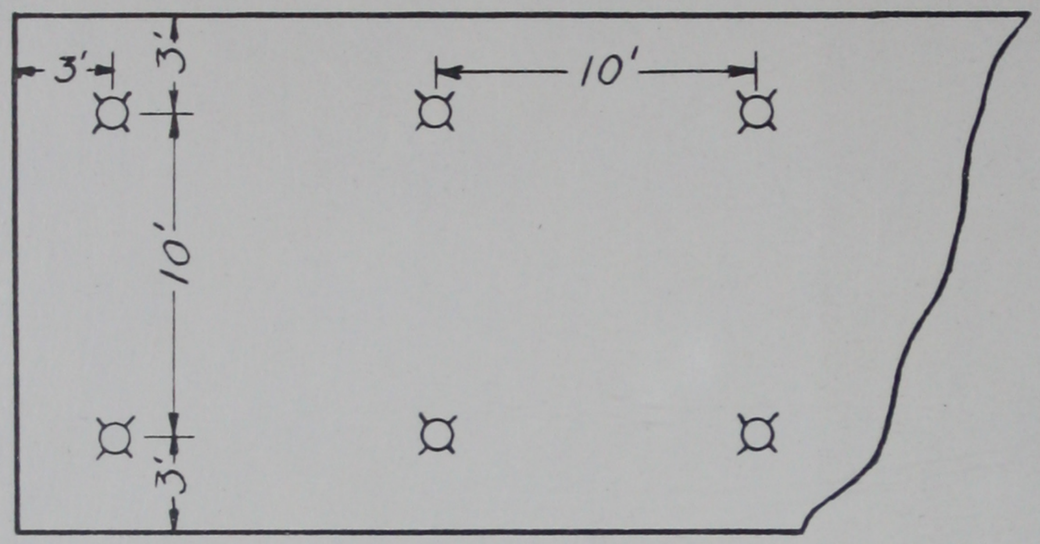




PLATE SEVENTEEN



The perception of objects in their three dimensions, so necessary in the industries, is relatively unimportant in offices and drafting rooms. Here, an ample supply of soft well-diffused light is required. Shadows and extreme contrasts in brightness should be avoided and the system selected should be easy to maintain and satisfactory in appearance.

These requirements are best satisfied by the use of some form of totally indirect or dense semi-indirect lighting unit, whenever the ceiling can be so finished that it will reflect a fair proportion of the light reaching it.

Data—Plate Eighteen

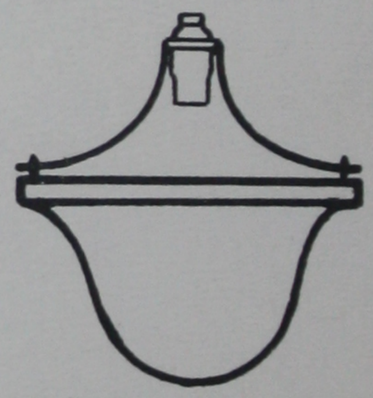
Type of Unit
Totally Indirect

Lamp
300-watt Mazda C
Clear

Mounting Height
3 feet below ceiling
9 feet above floor

Spacing Distance
10 x 10

Average Illumination
10 foot-candles



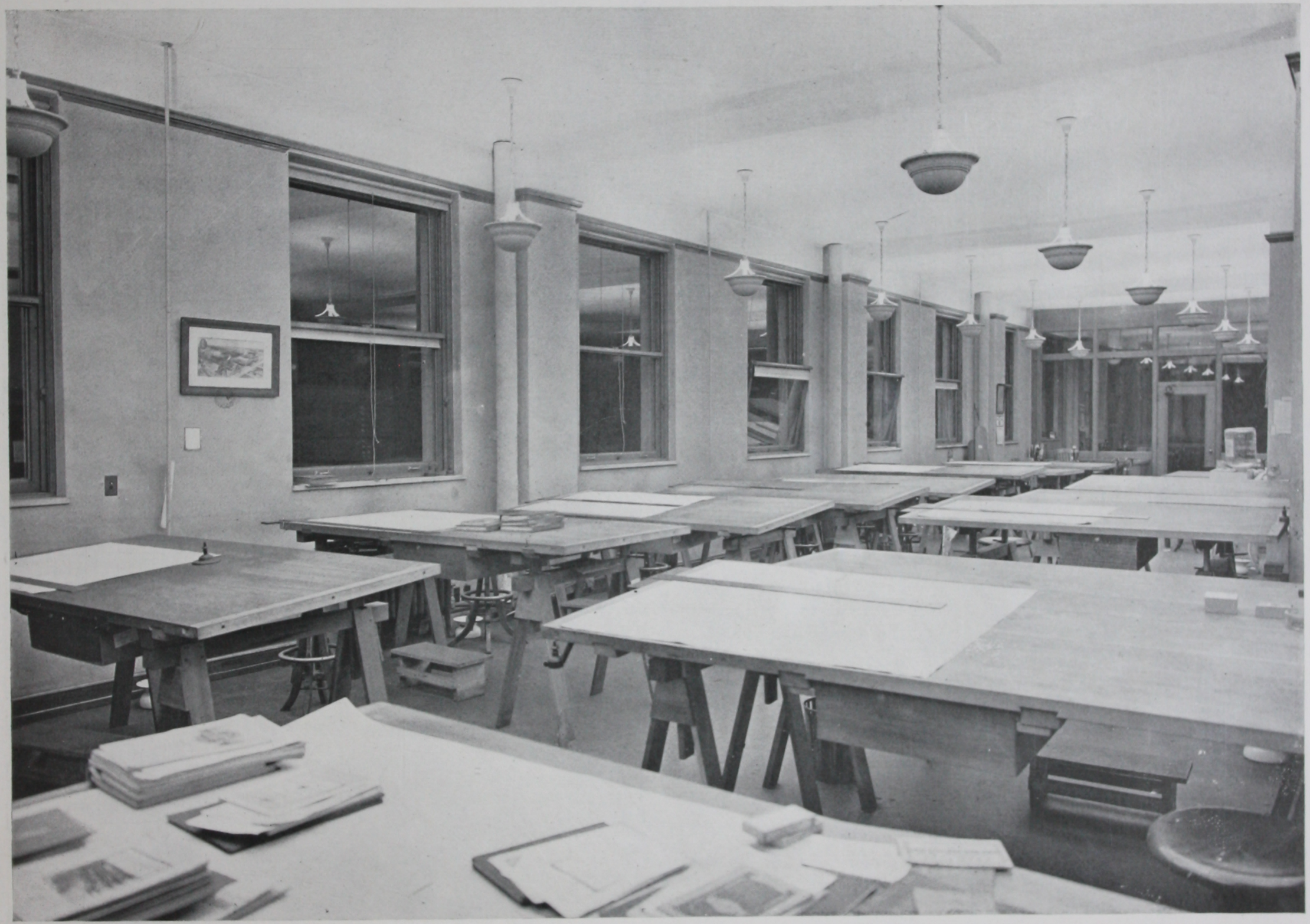
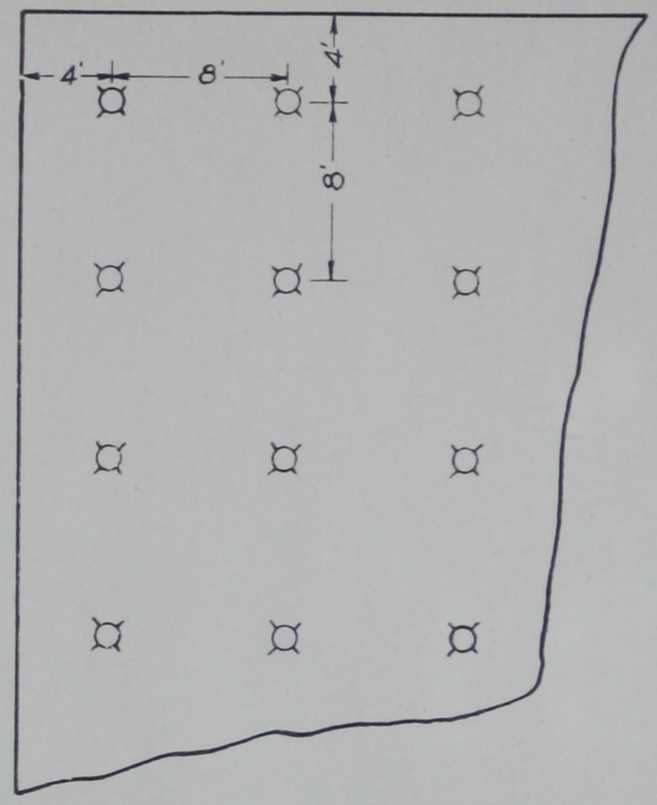


PLATE EIGHTEEN



Where structural features prevent the ceiling of a drafting room from being made a reasonably good reflecting surface, semi-enclosing units offer a quality of illumination which is next in choice to that of semi-indirect or totally indirect systems. For satisfactory results, the semi-enclosing units must be closely spaced and the entire installation carefully planned.

Data—Plate Nineteen

Type of Unit
Semi-Enclosing

Lamp
200-watt Mazda C
Clear

Mounting Height
9 feet above floor
6 feet above work

Spacing Distance
8 x 8

Average Illumination
13 foot-candles

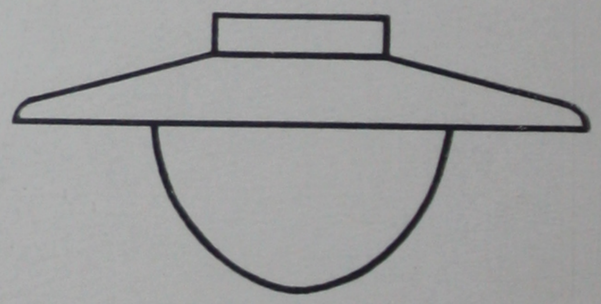
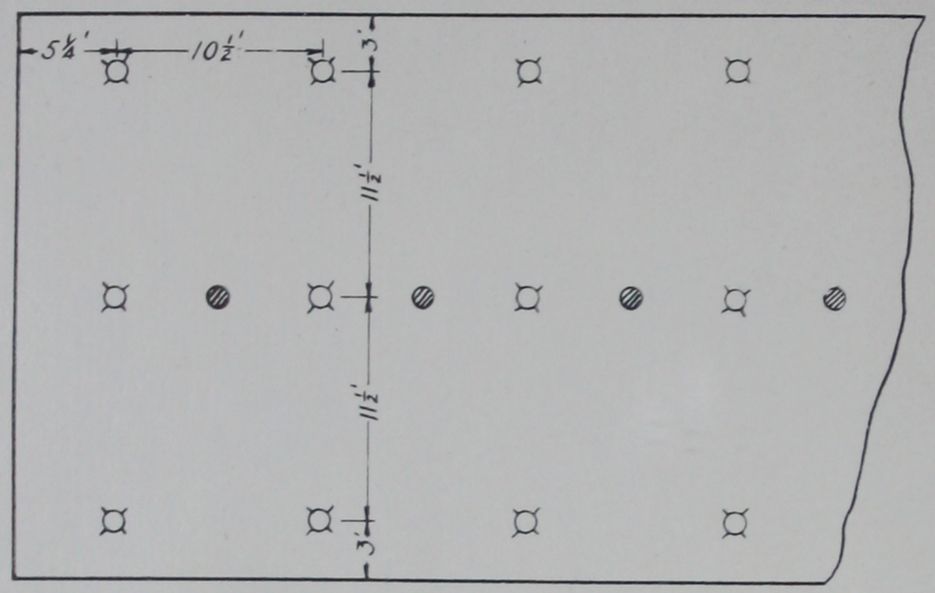




PLATE NINETEEN



Semi-indirect dense opal glassware provides for the requirements of office lighting in a satisfactory manner. With such a system, it is essential that the ceiling be light in color.

Note that the outside rows of units have been placed close to the walls in order to provide good illumination on the outside rows of desks.

Where artificial light is required to supplement daylight, the MAZDA C-2 daylight lamp may be used to advantage, because of the manner in which its light blends with daylight; about 50% additional wattage is required for equal illumination.

DATA—PLATE TWENTY

TYPE OF UNIT
Dense Opal Semi-Indirect

LAMP
200-watt MAZDA C
Clear

MOUNTING HEIGHT
3½ feet below ceiling
11½ feet above floor

SPACING DISTANCE
10½ x 11½

AVERAGE ILLUMINATION
8 foot-candles

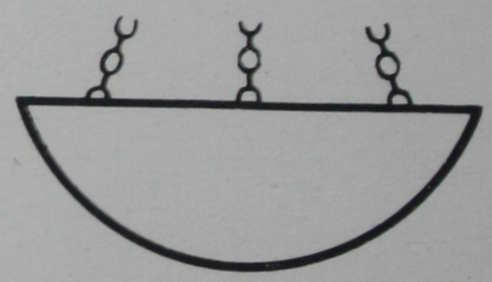


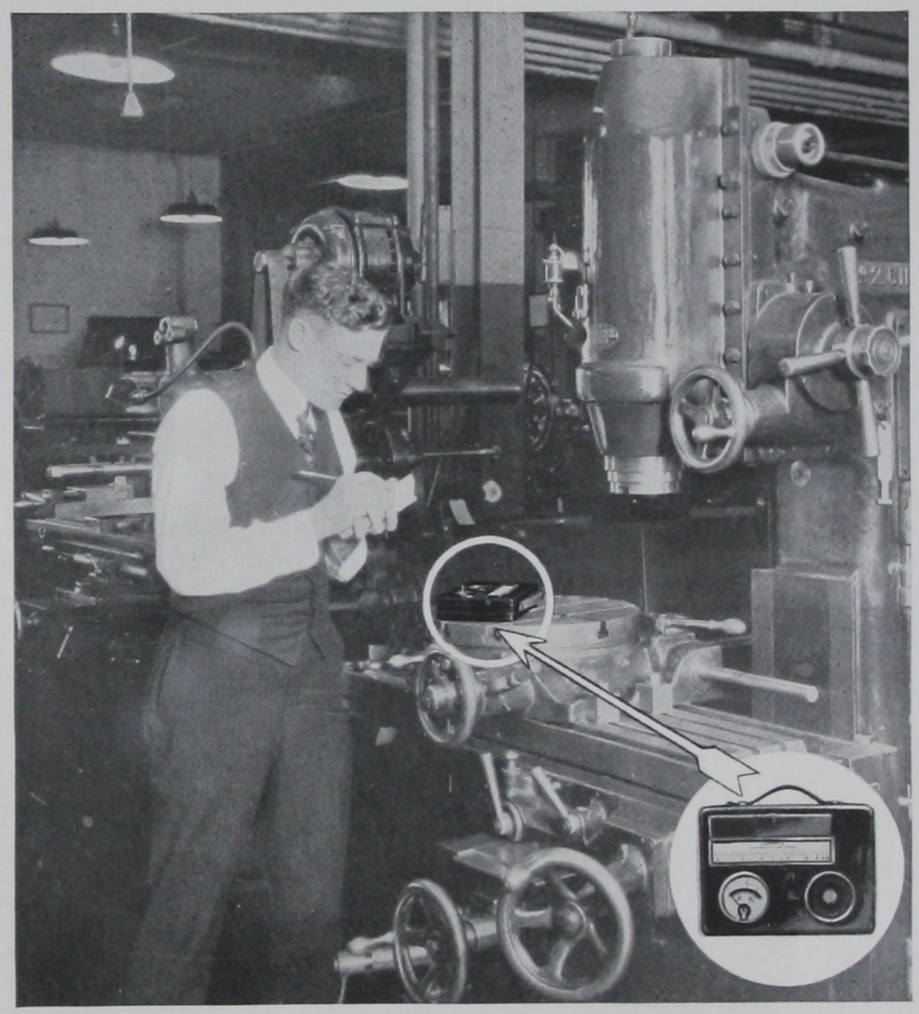


PLATE TWENTY

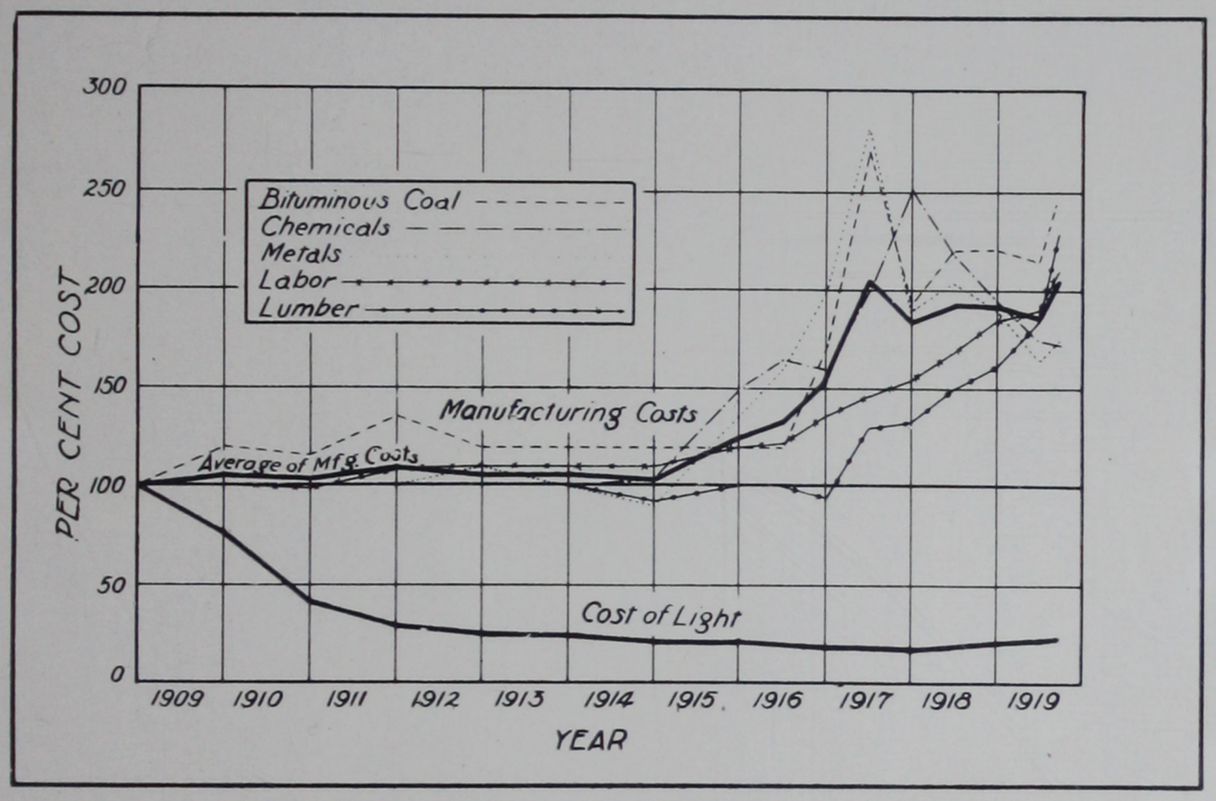
LIGHT MEASUREMENT

AT the time that the new interest in lighting was just beginning to be felt, came the development of an instrument called the Foot-Candle Meter, which makes the measurement of illumination a quick and easy matter. A glance at the scale of the instrument shows the intensity directly in foot-candles, the accepted unit of illumination measurement.

By actually measuring the light right down at the job, the Foot-Candle Meter eliminates guesswork. The plant manager can make sure that his men are getting sufficient light to enable them to see quickly and clearly and comfortably for long periods of time. He can prove to his own satisfaction that a few weeks' accumulation of dust and dirt upon the lighting equipment may cut the light delivered at the work to one-half or even one-third of the amount delivered when the equipment is clean; and he can formulate a cleaning schedule which meets his individual requirements. He can, by an occasional trip through his plant, make sure that the lighting is performing its function in the production program.



A Survey of Lighting Conditions is Easily and Quickly Made



THE COST OF LIGHT

A FRACTION of one per cent increase in factory output or decrease in accidents is enough to pay for good lighting in most industrial plants. Tests in a number of plants have shown increases of 10 to 20% in production following improvements in the lighting systems. Accounts of several of these tests have been published in many journals, one of the most complete treatments appearing in the Electrical Review of March 22, 1919.

Contrary to the trend of practically all other manufacturing costs over a period of several years, the cost of light has been almost continually decreasing. This is clearly shown in the accompanying curves. It will be noted that while costs as a whole have doubled since 1909, the cost of light is about one-fifth of what it was at that time; in other words, in terms of other manufacturing costs, light now costs one-tenth of what it did about ten years ago.

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